National Science Education Standards

Selected National Science Education Content Standards

Content Standards K-4

The activities found in this guide relate in part to the following content standards: Life Science, Earth Science, Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science. The concepts and principles outlined below have been transcribed directly from the National Research Council's publication National Science Education Standards. Please be aware that this is not a complete list of standards; only those addressed by the activities in the guide are present.

Life Science - Content Standard C:
As a result of activities in grades K-4, all students should develop an understanding of:

- The characteristics of organisms

Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.

Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

- Life cycles of organisms

Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.

Plants and animals closely resemble their parents.

Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment. Inherited characteristics include the color of flowers and the number of limbs of an animal. Other features, such as the ability to ride a bicycle, are learned through interactions with the environment and cannot be passed on to the next generation.

- Organisms and their environments

All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

Earth Science - Content Standard D:
As a result of their activities in grades K-4, all students should develop an understanding of:

- Properties of earth materials

Earth materials are solid rocks and soils, water, and gases of the atmosphere. The varied materials have different physical and chemical properties which make them useful in different ways, for example, as building materials, as sources of fuel, or for growing the plants we use as food. Earth materials provide many of the resources that humans use. Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply.

■ Changes in earth and sky

The surface of the earth changes.

Science and Technology - Content Standard E:
As a result of activities in grades K-4, all students should develop:

■ Abilities to distinguish between natural objects and objects made

Some objects occur in nature; others have been designed and made by people to solve human problems and enhance the quality of life.

Objects can be categorized into two groups, natural and designed.

Science in Personal and Social Perspectives - Content Standard F:
As a result of activities in grades K-4, all students should develop an understanding of:

■ Characteristics and changes in populations

Human populations include groups of individuals living in a particular location. One important characteristic of a human population is the population density— the number of individuals of a particular population that lives in a given amount of space.

The size of a human population can increase or decrease. Populations will increase unless other factors such as disease or famine decrease the population.

■ Types of resources

Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.

Some resources are basic materials, such as air, water, and soil; some are produced from basic resources, such as food, fuel, and building materials; and some resources are nonmaterial, such as quiet places, beauty, security, and safety.

The supply of many resources is limited. If used, resources can be extended through recycling and decreased use.

■ Changes in environments

Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and their quality of life.

Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad. Pollution is a change in the environment that can influence the health, survival, or activities of organisms, including humans.

Some environmental changes occur slowly, and others occur rapidly. Students should understand the different consequences of changing environments in small increments over long periods as compared with changing environments in large increments over short periods.

History and Nature of Science - Content Standard G:
As a result of activities in grades K-4, all students should develop an understanding of:

■ Science as a human endeavor

Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood. Science will never be finished.

Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

Content Standards 5-8

Life Science - Content Standard C:
As a result of their activities in grades 5-8, all students should develop an understanding of:

■ Structure and function in living systems

Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems.

■ Reproduction and heredity

Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms produce asexually. Other organisms reproduce sexually.

■ Regulation and behavior

All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

■ Populations and ecosystems

A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms.

Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

■ Diversity and adaptations of organisms

Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.

Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Science in Personal and Social Perspectives - Content Standard F:
As a result of activities in grades 5-8, all students should develop an understanding of:

■ Personal health

Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

■ Populations, resources, and environments

When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.

Causes of environmental degradation and resource depletion vary from region to region and from country to country.

■ Natural hazards

Internal and external processes of the earth system cause natural hazards, events that change and destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include

earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids.

Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much for unneeded preventive measures.

■ Risks and benefits

Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earth-quakes, and volcanic eruptions), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and with personal hazards (smoking, dieting, and drinking).

Important personal and social decisions are made based on perceptions of benefits and risks.

■ Science and technology in society

Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment. The effect of science on society is neither entirely beneficial nor entirely detrimental.

Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.

Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions. They should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.